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AFTERBURNER COMBUSTION MEANS

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Fig. 2

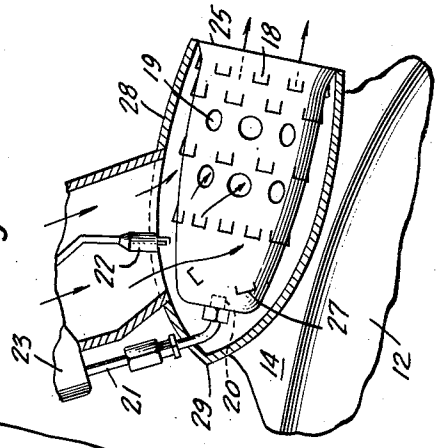


Fig. 1

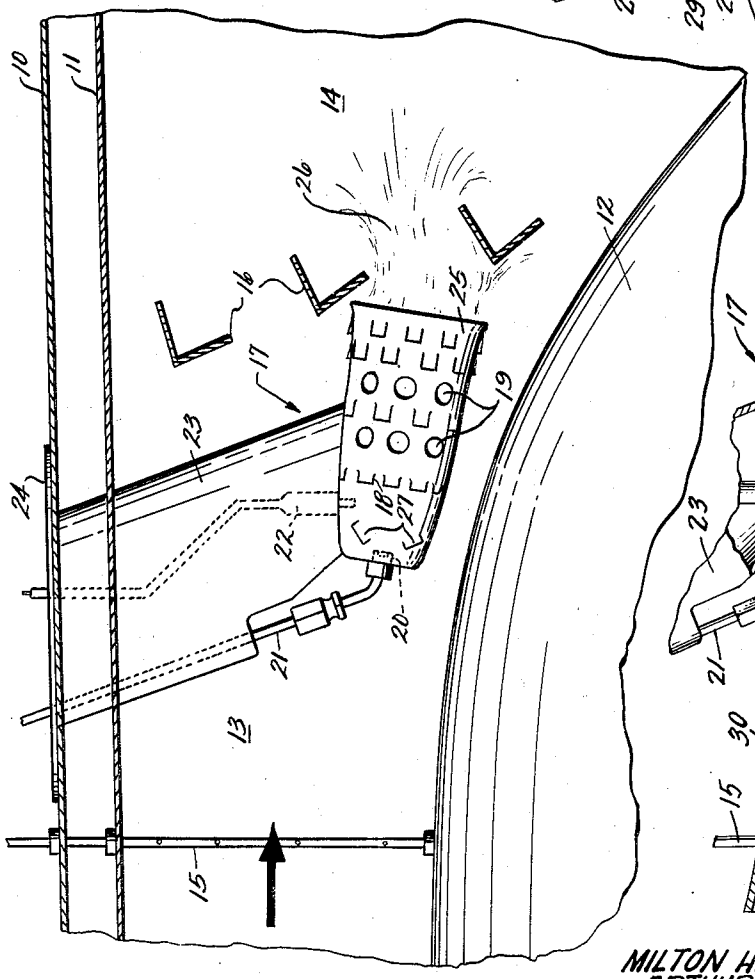
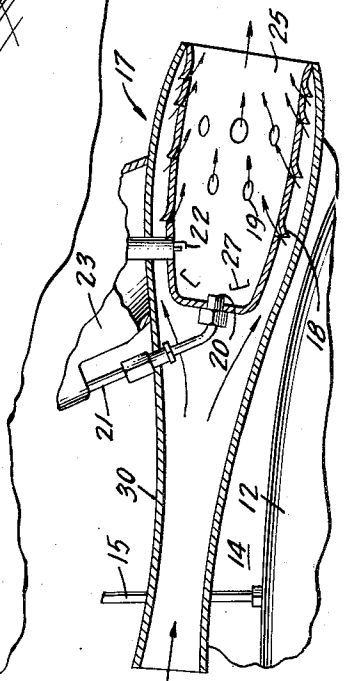


Fig. 3



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AFTERBURNER COMBUSTION MEANS

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The present invention relates to an afterburner combustion means for a reaction-type power plant, such as a turbo-jet engine, and, more particularly to a pilot burner for the continuous ignition in the afterburner of a turbo-jet engine.

In present day jet engines, it is common to provide for thrust augmentation by means of an afterburner which is supplied with additional fuel to combine with the excess air in the exhaust and supply additional burning in the afterburner for more thrust under certain operating conditions. However, when the turbine exhaust gas temperature is below a temperature at which the fuel-air mixture will ignite spontaneously, ignition must be provided. In addition, the fuel and air mixture moves at extremely high velocities so that ignition is difficult. The problem lies in preventing the flame front from being swept out of the afterburner before the combustion process is completed. A conventional means for slowing the exhaust gas velocity is to provide a flameholder within the duct to set up an obstruction and permit a flame to be established in the lower velocity areas created by the obstruction. However, it is still necessary to create the flame by some ignition means and maintain the flame if the flameholder is to function properly and avoid non-ignition and blow-out.

Many means have been devised to provide ignition for the afterburner, such as the "hot streak" which consists of injecting fuel upstream of the turbine wherein the hot gases coming from the combustors ignites the fuel and carries it downstream to light off the afterburner. This has the disadvantage of passing the burning matter through the turbine. Another method tried experimentally is the use of capsules containing chemicals which ignite upon release in the exhaust gases and thus ignite the afterburner. This method raises control problems in that the capsules are difficult to handle and control for proper and continuous ignition. Other sytems employ flame ignition sources in the afterburner of various shapes and configurations and generally require the use of a substantial amount of hardware to provide even burning in the afterburner which hardware has a relatively short life. Others provide ignition sources within the afterburner requiring different fuel from that used by the engine creating a transportation and storage problem, and being subject to difficulty if a blow-out occurs and re-ignition is attempted.

The main object of the present invention is to overcome the difficulties listed above and provide an afterburner ignition means which employs the principles of an elemental combustion burner.

Another object is to provide such an ignition means which utilizes a simple, open-ended basket burner located near the flame stabilization point of the afterburner, but upstream of this point, to insure long life for the burner.

A further object of the invention is to provide such ignition means which employs standard fuel as used by the engine and obviates additional handling and storage problems.

Still another object of the invention is to disclose such an afterburner ignition means which is designed to operate continuously during thrust augmentation and to re-ignite rapidly in case of a blow-out.

Briefly stated, in accordance with the preferred aspect of our invention, we provide an open-ended basket disposed in the diffuser passage of a reaction engine between the liner and tailcone with the open end directed downstream. The basket is located between the conventional spray bar and flameholder and is preferably disposed on the r adially inner half of the diffuser passage to avoid hot spots on the liner. The basket is provided with suitable louvers and air inlet ports to entrain fuel and exhaust gases or compressor bleed air if desired within the basket for ignition by any suitable ignition source.

My invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

Fig. 1 of the drawing is a cross-sectional view of a typical turbo-jet engine designed for afterburner operation showing the application of the ignition means thereto, although it is to be understood that it is applicable to any reaction type powerplant requiring thrust augmentation.

Fig. 2 is a cross-sectional view of a portion of a turbo-jet engine showing a modified form of our invention.

Fig. 3 is a cross-sectional view of a portion of a turbo-jet engine showing another modified form of our invention.

Referring now to the drawing, there is shown the diffusion section of a typical reaction engine, such as a turbo-jet. The diffusion section is composed of an outer casing **10**, an inner casing or liner **11** spaced therefrom for the passage of cooling air therebetween, and a tailcone **12** concentric with the casings. The exhaust gases from the turbine located upstream, not shown, are slowed in diffuser **13** as they pass into the afterburner section **14** to exit from any suitable nozzle, not shown, and provide the propulsive effect for the powerplant. To provide additional fuel for afterburner operation, a suitable spray bar arrangement **15** may be employed in the upstream end of the diffuser section. Such structure is conventional and need not be further described.

Even with the slowing down of the velocity provided in the diffuser section, the exhaust gas velocity is extremely high and difficult to ignite. To provide suitable areas of ignition, it is customary to insert a flameholder which may be of the three-ring V-gutter type shown at **16**. The various rings are connected together in any suitable manner. The shape of the flameholder gutters creates eddies on the downstream edges thereof to provide quiescent areas that may be ignited.

The structure, thus far described, will provide for satisfactory afterburner operation once a flame has been established and stabilized. To insure that this will happen, we provide an open-ended basket, generally indicated at **17**, in the diffuser passage **13** between spray bar **15** and flameholder **16**. The basket is perforated by outwardly opening louvers **18** facing in the upstream direction and any suitable number of these may be provided as will hereinafter appear. In addition, air inlet ports **19** may be spaced in the basket between the louvers. The upstream end of the basket is closed, except for a suitable fuel nozzle **20** supplied with engine fuel by means of line **21** which passes out of the diffuser passage as shown. Original ignition of the pilot burner or basket is provided by a spark source **22** supplied from an outside source not shown. Spark source **22** is preferably located upstream of the air ports **19** for a purpose that will become apparent. A suitable airfoil **23** may surround the line **21** and the connection to spark source **22** to protect them from the hot exhaust gases. In order to replace the unit

easily, airfoil 23 may be connected to plate 24, which is fastened to outer casing 10, permitting the entire pilot burner assembly to be withdrawn through the casings and replaced when necessary. Preferably, the downstream end of basket 17 is flared as at 25 to provide a large area of flame adjacent the flameholder and downstream thereof.

One of the difficulties encountered in the instant type of pilot burner is that of carbonizing on the inner skin of the burner and the improper location of the burner to create hot spots on liner 11 and require the frequent replacement thereof. As the exhaust gases pass downstream, as indicated by the arrow, and are enriched with fuel from spray bar 15, the portion adjacent the outer surface of basket 17 is sliced off by the louvers 18 to direct the mixture into basket 17. The louver arrangement permits a thin boundary layer of these gases to surround the inner surface of the basket and prevent the carbonization thereof. In addition, because of the open end downstream a low pressure area is created within the basket to draw this mixture plus additional outside exhaust gas and air through ports 19 in a swirling or turbulent fashion within the burner. The upstream portion of the burner being the lowest pressure area draws the incoming mixture forwardly to combine with additional fuel supplied by nozzle 20 and insures thorough mixing thereof, since this portion provides a low velocity region wherein it is much easier to ignite the fuel and gas mixture. Spark source 22 is preferably located in this low velocity zone to guarantee ignition. Upon ignition, the expanding gases rush downstream and out the flared end of the basket 17 to create additional impetus to the inward flow of gases through louvers 18 and ports 19 and complete the cycle.

Proper ignition of the afterburner is provided by the flame or torch 26 which occurs in the area of the flameholder. Because the flame at the flameholder is at a very high temperature, it is desirable that it be located away from liner 11 to avoid burning and hot spots necessitating frequent replacement of the liner. This difficulty is overcome by locating basket 17 in the radially inner and middle gutters of the particular flameholder shown.

The number and arrangement of the louvers 18 and ports 19 may vary depending upon the particular design and engine characteristics. It is merely necessary to supply sufficient air inside the basket so that the additional fuel supplied by nozzle 20 will burn in an efficient and controllable manner. In order to prevent the pilot burner from burning out the flameholder rings, it is desirable that the pilot burner be located adjacent the rings to prevent the impingement of the hot flame thereon. If desired, the forward louvers may be set at an angle as at 27 to provide initial swirl to the incoming gases. However, this is not necessary for successful operation of the instant pilot burner providing the arrangement described is complied with.

While we have illustrated the preferred form of the instant invention with the basket in the exhaust stream, it may be desirable to employ other means to supply

the air required such as a shroud 28 shown in Fig. 2 which surrounds the basket being aerodynamically formed to provide for streamlined flow, the shroud being closed at the flared end 25 of the basket and pointed as at 29 upstream. In such a modification, air from a suitable source as the compressor may be supplied through airfoil 23 to the chamber between the shroud and basket.

Alternately, the shroud may be extended by a pipe means 30 as shown in Fig. 3 to provide an inlet upstream of spray bar 15 so that exhaust gases, undiluted by the extra fuel from the spray bar, are funneled to the chamber surrounding the basket. In either modification, the basket as described, is used.

It will be apparent that the pilot burner may be located in one or more additional locations although a single pilot burner, in accordance with the present invention, has produced satisfactory ignition under all conditions of afterburner operation.

While a particular embodiment of the invention has been illustrated and described, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the invention, and it is intended to cover in the appended claims all such changes and modifications that come within the true spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent is:

1. In an afterburner equipped reaction engine having an outer casing and an inner tailcone defining an annular diffusion passage therebetween, fuel spraying means in said passage, flameholder means in said passage downstream of said spraying means, and afterburner ignition means for providing a continuous torch of flame during afterburner operation including a generally cylindrical basket having one open end therein facing downstream, said end being open to the annular passage over its full cross-sectional area, said basket having at least one air inlet port therein, said basket being disposed between said spraying means and said flameholder, and fuel and ignition means connected to the inner portion of said basket.

2. Apparatus as described in claim 1 wherein said basket is disposed in the radially inner half of said annular passage.

3. Apparatus as described in claim 1 wherein a shroud surrounds the basket and extends upstream of the fuel spraying means to provide exhaust gases to the basket which are undiluted by fuel from the fuel spraying means, said shroud being open at its upstream end and attached to the basket in sealing relation at its downstream end.

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